CASE STUDY

Intel® HPC Orchestrator
Intel® Scalable System Framework

University of Pisa Delivers Agile HPC to Empower Hundreds of Researchers

UNIVERSITÀ DI PISA

From quantum chemistry and nanophysics to genome sequencing, proteomics, and engineering simulations, researchers at the University of Pisa are using high performance computing (HPC) across an increasing variety of research disciplines. HPC has become a foundational resource for more than 200 users who are working to push the boundaries of knowledge at the prestigious university. Demands for HPC are growing beyond traditional HPC disciplines as well, including areas such as big data analytics, data visualization, and machine learning.

This growing array of HPC demands is creating new challenges for the University of Pisa's IT Center. Research teams use a variety of different applications, many of which have unique software dependencies. Supporting this growing and continuously changing software portfolio requires extensive integration and testing. To reduce the time and administrative overhead for this process, the IT Center is currently utilizing Intel® HPC Orchestrator, which provides a pre-integrated HPC software stack designed to greatly simplify software installation and maintenance.

Faster Deployment of Customized Software Stacks

After working with Intel HPC Orchestrator in their test environment, the University of Pisa's IT staff see great potential for this new approach. According to Maurizio Davini, Chief Technical Officer for the University of Pisa, "University of Pisa's average HPC system software stack build, with Base OS pre-installed, and validation for 32 Compute Node system may take up to one or two days. The implementation of Intel HPC Orchestrator, with Base OS pre-installed, was accomplished in a few hours."

From Dedicated Clusters to Cloud-based Solutions

The University of Pisa has five small to medium sized clusters onsite, ranging in size from 10 to 60 nodes. They also have an on-premise private cloud based on Dell Hybrid Cloud System* for Microsoft. This integrated, Intel® architecture-based cloud platform runs Windows* Azure Pack, which allows them to deploy Microsoft Azure* services on premise.[1] Davini and his team have verified that they can use Intel HPC Orchestrator for both bare metal and virtual deployment models, so they can use the same software tools whether they are providing dedicated physical infrastructure or a cloud-based cluster solution.

Research teams with less demanding performance requirements have been thrilled with the private cloud solutions. According to Davini, "We're seeing a lot of new players in the HPC space that can't justify the expense of a dedicated physical cluster. We recently had a team of acoustics researchers, for example, that needed a small cluster for just a few weeks. With Intel HPC Orchestrator and our private cloud, we can address these kinds of requests faster and with less effort."

A Better Foundation for Agile HPC

Intel HPC Orchestrator is based on the OpenHPC community system software stack, which is hosted by the Linux* Foundation. OpenHPC includes a comprehensive set of commonly required HPC components, such as provisioning and resource management tools, I/O libraries, and numerous scientific libraries. Intel works with the open source community to deliver new functionality and to optimize code for high performance and reliability on Intel architecture. With Intel HPC Orchestrator, Intel adds value through additional testing, validation, and professional support, plus a number of proprietary software components that aid in system support and application development.

Davini believes that Intel HPC Orchestrator may ultimately deliver many additional benefits for the university, including:

- **Faster access to emerging HPC technologies.** Intel has the resources and relationships needed to continuously upgrade, test, and validate Intel HPC Orchestrator. Easy access to a high quality, up-to-date stack could make it easier for the University of Pisa to take advantage of emerging software and hardware innovations.
- **Greater flexibility to meet changing user demands.** Intel's vision for Intel HPC Orchestrator is to provide a modular, standards-based software stack capable of supporting the full range of HPC requirements, including user groups that may have little or no experience with HPC. As the system software stack evolves, it could make it easier for the university to extend HPC support to new classes of users.
- **Simpler application development.** Intel HPC Orchestrator includes a variety of languages, such as Fortran, C+, and C++. Other languages, such as Python, Java, and .NET are available through the base operating systems that Intel HPC Orchestrator is validated to run with.[2] This flexible support may help a new generation of HPC developers leverage their existing skill sets to develop and port applications to HPC systems.

"We believe these two companies are at the forefront of innovation in high performance computing. We also share a common goal of simplifying HPC to support a broader range of users."

– Maurizio Davini, Chief Technical Officer for the University of Pisa

Collaborating to Simplify HPC

The University of Pisa IT Center has been working formally with Intel and Dell since 2013 to evaluate many additional technologies, both for HPC and for enterprise computing. "We believe these two companies are at the forefront of innovation in high performance computing," says Davini. "We also share a common goal of simplifying HPC to support a broader range of users. Ultimately, we would like to be able to provide solutions that are simple and affordable enough that individual researchers, and even small businesses, can deploy and use them with relative ease."

The collaboration with Intel and Dell helps the university embrace new technologies quicker and with less risk. The IT Center does not have to invest as many resources to track innovation at the component level and to integrate and test all the individual hardware and software components. Instead, they can build their solutions on top of a proven solution stack. Intel and Dell also benefit from the relationship. It helps the two companies better understand the challenges of real-world HPC deployments, so they can address them even more effectively in next-generation solutions.

Taking Performance and Scalability to the Next Level

Intel HPC Orchestrator is just one component of the Intel® Scalable System Framework (Intel® SSF), a flexible blueprint for cluster designs that can scale affordably to address even the most extreme HPC requirements. Intel SSF brings together Intel's latest compute, memory, storage, fabric, and software technologies to help organizations scale performance more cost-effectively for HPC workloads.

As part of their collaboration with Intel and Dell, the University of Pisa IT Center is working to evaluate and test additional components of Intel SSF running on Dell hardware, including:

- **Intel® Xeon Phi™ processors,** which provide up to 72 cores per socket for accelerating highly parallel applications. These many-core processors can be used either as accelerators or as standalone processors to run any x86 code, without rewriting or recompilation.
- **Intel® Solid-State Drives for PCIe,*** which are designed to overcome the performance, latency, and bandwidth issues not only of standard mechanical drives, but of comparable SSDs that communicate over traditional, and much slower, SATA interfaces.
- **Intel® Omni-Path Architecture,** a high-speed cluster fabric that is designed to provide comparable performance to EDR InfiniBand, but with cost models that help to stretch the value of HPC budgets.

The university's IT Center has had positive experiences with each of these components, and offers a number of blogs and technical reports that provide guidance on setup and use. For some components, they have moved into performance testing, and have already demonstrated substantial gains in particular use cases.

For the latest information, visit: www.intel.com/hpc orchestrator

"We have high expectations for Intel SSF in general, and for Intel HPC Orchestrator in particular," says Davini.

A Clear Path into the Future of HPC

Intel will continue to drive balanced innovation throughout the HPC solution stack by developing new technologies, integrating them into Intel SSF, and working with Dell and other vendors to deliver cost-effective, production-ready solutions. A number of breakthrough memory and storage technologies, for example, will help HPC users move large datasets closer to processor cores to resolve the age-old performance challenges associated with memory and storage bottlenecks. Intel is also integrating fabric controllers into current Intel Xeon Phi processors and future Intel® Xeon® processors. This integration will help to enable ongoing performance gains, while eliminating the cost and complexity associated with separate add-on fabric cards.

The University of Pisa IT Center will work with Intel and Dell to evaluate these and other emerging technologies for HPC. "We have high expectations for Intel SSF in general, and for Intel HPC Orchestrator in particular," says Davini. "HPC technologies are advancing very rapidly. Only time will tell for sure, but if these resources can help us deliver higher performing HPC solutions with less cost and effort, they will be tremendous resources for our university."

Get More Information

Intel® HPC Orchestrator
www.intel.com/content/www/us/en/high-performance-computing/hpc-orchestrator-overview.html

Intel in HPC
www.intel.com/content/www/us/en/high-performance-computing/server-reliability.html

University of Pisa IT Center
www.itc.unipi.it/

[1] Although applications running on Dell Hybrid Cloud System for Microsoft can theoretically run without change on Microsoft Azure public clouds, the lack of support for PXE boot in public clouds prevents easy replication in this case. Future releases of Intel® HPC Orchestrator may help to resolve this current limitation.

[2] As of October 13, 2016, Intel® HPC Orchestrator is validated to run with Red Hat Enterprise Linux 7.2 and SUSE Linux Enterprise Server 12sp1. Python and Java are available through these operating systems. .NET is available through the open source Mono project.

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